Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE PUPIL'S EXPERIENCE AS THE SOURCE OF HIS PROBLEMS IN ARITHMETIC

In attempting in this school to utilize the sense-impressions and imagery of the individual pupil in the teaching of arithmetic, we have not only drawn upon the fund of objective experience which is common to all children in their life outside of the school room, but have endeavored as far as possible to make use of school activities and experiences of the children which incidentally entail a large amount of mathematical work and supply a body of imagery that becomes the basis of their mathematical knowledge.

Utilizing objective experience and imagery of the individual pupil in arithmetic applies both to the formal phase of the subject and to the selection and solution of applied problems. It would be a very exceptional and backward school which today did not attempt to rationalize the tables, formal processes, and rules of arithmetic by providing opportunity for each individual pupil to discover or formulate these for himself out of his own concrete experience. It has been the ideal, since the time of Pestalozzi, thus to free the pupil in the formal work from the mere slavish following of rules, by building, through objective teaching, a body of imagery in his mind upon which the processes of arithmetic are rationally based. But has the ideal prevailed in the selection and presentation of the problem material of seeing that the pupil is really provided with adequate experience and imagery for its interpretation?

In order to make the applied problems of arithmetic concrete to the pupil, they must be made to relate to his own activities and experiences. The trouble with the problems of textbooks is that they are not local in character and do not appeal to the experiences and interests of the individual pupil. They are written for use throughout the whole country, and hence must be of only general appeal. Furthermore, many of the problems of most textbooks are mere puzzles, and not the real problems that are encountered by any one in actual life. The chief danger lies in the fact that the textbook problems are to a great extent the problems of adults and not the problems of children at all. They deal with the business of the adult's world, and with matters with which children have as yet had no contact. The imagery

necessary for their interpretation is not possessed by children, because of their lack of experience with the things with which the problems deal. This is what makes the interpretation and solution of applied problems so difficult for children. The inference is inevitable. If the problems of arithmetic are to draw upon the imagery of the pupil, the textbook must be supplemented by problems that are local in character and that have to do with the pupil's own activities.

There is another weighty reason for the problems of the textbook being supplemented in every school and in every community by local problems of personal appeal to the pupil. In practical life the problems which one encounters are not already formulated and printed, but are involved in practical, concrete situations. Success in practical life, then, demands that he who faces a problem shall first interpret the situation involving it and formulate the problem for himself. It is training in this power, rather than in the power to interpret an already formulated problem, that is needed. We need to teach the pupil the art of problem making as well as the art of problem solving.

It follows that if the fundamental principle of "learning to do by doing" is to be applied in the teaching of arithmetic, pupils must have opportunities of acquiring the ability to interpret and formulate their own problems from concrete situations by *practicing* work of this character in the school. Training in the solution of book problems alone will not develop this ability. That this is a significant truth is attested by the universal complaints of business men that boys and girls who are the products of the public schools cannot put into practice the knowledge which they have acquired. They are trained to do one type of thing and in practical life are called upon to perform another. It is evident, therefore, that the school life of the pupil must include activities which involve a great deal of mathematical experience and imagery, and which demand incidentally the formulation as well as the solution of arithmetical problems. This mathematical experience should parallel and supplement the textbook work.

The following examples show how the children in the second grade formulated and solved problems connected with school activities in which they were engaged. Thus, these children were personally caring for chickens at the school. The problems about chickens, eggs, and chicken-feed grew out of this personal experience. The problems about looms and rugs also were formulated while the children were engaged in making looms and using them in weaving rugs.

My father brought me two dozen little chickens. I was down town and I said to my mother, please buy me some more chickens. She did and there were four dozen. Altogether I had forty-eight little chickens.

Alice.

I had 16 eggs and the hen could not sit on so many eggs, so I took from her 4, and how many did I have left? 12.

Sophy.

I had a bag of grain that weighed 20 ounces, and a rat came and ate 10 ounces. It left 10 ounces.

Frances.

I wove a rug which was twenty-six inches long. I had to take out two inches. How many were left? Twenty-four inches long.

Alice.

I had 12 balls of yarn. I wove 4 balls of it. How many balls did I have left? Eight. Janet.

I had a rug. I made a camel in the center of the rug. He was 10 inches high. I made a mistake. I had to take 7 inches out. How many inches were left? Three. H. P.

We made looms in school for our rugs. We needed 35 nails on one side. Yesterday I put in ten. I will need twenty-five more.

Katherine.

I had 47 nails in my loom and Miss Dewey said I could not have so many nails. I took out 12 of them. How many are left in my loom? Thirty-five. Anna.

Many of the activities which the school should use as a natural basis of arithmetic work are those in which the pupils are engaged outside of school. We believe that it is the foremost function of the school to teach the child to do efficiently, or better than he could do without such guidance and instruction, those things which he is trying to do and wishes to do in the home, in his play, etc. This it can do only if it utilizes the child's own experiences and activities as the basis of teaching. Such appeal to the pupil's present activities not only enables him to do better those things which make up his life in the present, but also provides the best kind of development as preparation for his future.

Among the free activities of children outside of school that may thus be continued in the school room is the playing of various kinds of games, which is the main business of childhood. These games are of several different types. Some involve the principle of contest, and include various scoring games. Others involve imitation of real community activities, such as keeping store, playing fireman, etc. Other games are primarily games of activity, such as, "Pussy wants a

corner." The idea of utilizing so-called number games in school is now generally accepted, and this type of mathematical work is done in many schools. This form of activity has been utilized in our school to a greater or less extent in most of the elementary grades.

A discussion with our third-grade children of the kinds of mathematical experiences or activities which they engage in outside of school revealed the fact that most of them are provided with allowances of money by their parents. This illustrates another type of quantitative experience of children outside of school that might be made the basis of mathematical work in the classroom. A great variety of problems and drills may be devised that will make the children more efficient in their use of these allowances, and at the same time make them more proficient in certain formal work of arithmetic. Thorough investigation by the teacher of any grade should reveal many such quantitative experiences of children which might provide a body of concrete problems and drills based upon the children's active personal interests, such mathematical work possessing the highest value in that it helps the children to live more efficiently the lives which they are trying to live in the present.

The correlation of arithmetic with the other subjects of study, such as handwork, household arts, elementary science, and geography, provides, of course, a rich fund of objective mathematical experience and imagery. In addition to the foregoing, in this school more or less extensive projects are carried on in different grades as part of the regular school activities which afford admirable means of learning arithmetic by using it, and of building up incidentally a body of mathematical imagery which the pupil does not bring from outside of school.

Some projects or activities in our school that involve the building of mathematical experience and imagery have been described from other points of view in former volumes of the Year Book. Among these is the care of a number of chickens at the school by the children of the second grade, described in Volume I. That report shows the character of the number work involved in this grade activity. In the same volume is an article describing the building of a "club house," or play house, as a project of the eighth grade. That report indicates how the children of the eighth grade learned the relation between the sides of a right triangle, and mastered board measure and square

root incidentally as a part of the project. Other articles in the present volume, while written from a different point of view, show still other examples of activities in the school involving a large body of arithmetic work based upon real experience. See, for example, the article on the study of foods and food supply. See also the article on banking by the pupils of the seventh grade.

The activity described in the last named article is illustrative of a type of activity that may be provided at many points of the arithmetic course. It consists of a dramatization of business processes. Many of the topics of business which must be taught in the elementary school are beyond the experience of the average boy or girl, especially the latter. For example, the dealings with a bank, borrowing or lending money at interest, discounting bills, or dealings with stocks or bonds, are matters with which pupils of the elementary school have had little or no vital contact. If these topics are to be taught, it is imperative that the school shall provide the experience and mental imagery which are lacking. One way to supply these is to take the pupils on excursions to visit banks, business houses, brokerage offices, etc. But this alone is not sufficient. The most effective way is to apply the principle of "learning to do by doing" by having the pupils perform the business processes in make-believe fashion. Thus, in the third grade they may operate a make-believe city gas company, electric light company, or water company, and pay their monthly bills at the "office" of the company. In the fourth grade they may, as our fourth grade has done, conduct a store, and write, compute, and pay for bills of goods at this play store, etc.

This school conducts a store through which the pupils purchase practically all of their supplies, such as books, writing tablets, pencils, erasers, drawing instruments, etc. It conducts a lunch room also, at which the lunch is paid for by lunch tickets. In order to avoid the necessity of the children carrying spending money, the parents of all pupils are required to keep at the school a deposit upon which the pupils draw by checks in making purchases of supplies or lunch tickets. This constitutes a school bank account, and is operated like a real bank of deposit. Each pupil is given a check-book which provides blanks for carrying forward his balance from stub to stub. Monthly statements are issued as at a regular bank. Pupils whose balances do not agree with those of the bank are required to find their errors and correct them. The process operates in all grades above the second.

In the first and second grades, the teachers have to fill out the checks for the children. This plan gives all children above the second grade not only knowledge of the use of checks on a bank of deposit, but a large amount of practical experience in computation throughout their school course. It has the special value that the activity is genuine and not artificial in any sense, that it is motivated by the vital personal activity of each pupil, and that it affords a body of mathematical experience extending continuously throughout the elementary and high-school life of the pupil.

The chief effort in the teaching of number in the lower primary grades of our school is given to building, through various forms of purposeful activities of the children, a body of mathematical imagery that shall form a basis for the formal number facts and of the problems. The general character of this imagery-building may be indicated by the following outline of some of the sources of mathematical experience in the second grade.

The care of chickens at the school and the sale of the eggs by the children of the second grade, to which reference was made above, provide a large fund of experience running throughout the year. This includes buying and paying for the feed, measuring out and feeding the chickens the daily ration, collecting and selling the eggs, and making and repairing various articles used in and about the chicken quarters. The latter develops a working knowledge of the foot rule and yardstick. Each day the children take to the henhouse a definite quantity of grain. When a new fifty-pound bag arrives, it is delivered to the class-room, and before school each day an appointed child weighs out the daily ration. This power is developed during class drills, when the children learn to handle and name 1 lb., ½ lb., ¼ lb., ⅛ lb., and 1/16 lb. weights. During the winter and early spring the children conduct an egg store in the lower hall of the building, selling the eggs on hand each Tuesday immediately after morning exercise. The two sales people in charge of the store must know the prices of eggs from one to a dozen, and also must know how to accept and return proper change. For example, if a customer buys a dozen eggs for 36 cents, the salesman must select the change from his money-drawer. Of course, drills on the number tables precede the weekly sales, and between times the children in class play store with one another so that the sales people may be chosen wisely.

In addition to drills on number tables, the work with the chickens

demands a knowledge of the different coins, of the writing of dollars and cents, and of the addition and subtraction of dollars and cents. For developing this knowledge, use is made of artificial coins which the children make of cardboard. This toy money is used also for teaching the idea of the decimal notation of numbers, by letting pennies stand for units and dimes for tens, and for teaching the processes of carrying in addition and of changing from higher to lower denominations in subtraction. The chicken expense items are counted with this toy money until real money is earned from the sale of eggs, when it is discarded for real currency.

In the fall the children make boxes to hold their toy money. This, too, provides experience with the ruler. During the making of their boxes the children have occasion to name, find on their rulers, and use ½, ¼, and ⅛. This and other uses of the ruler, and work with weights of different fractions of a pound, give considerable knowledge of fractions up to 1/16 and of their relations.

The table of liquid measure is learned in various ways. Some use of it is provided in the work in cooking, some in connection with the chickens, and some in experimental work on making lye and dyeing yarn for weaving rugs. A favorite exercise is to "picture" how much milk each class drinks at luncheon during one school week. Each day during the week they "picture" with water the amount of milk drunk, and when they see the week's amount measured by water in a tub, they are delighted.

Another activity of the second grade which affords much mathematical experience and imagery is the study of foods, discussed in an article of this volume, and still another consists of a study of shepherd life which is carried on in this grade, a part of which involves the dyeing and weaving mentioned above. Of course, the activities here mentioned do not include all of the sources of number experience in the second grade. Among other activities employed have been various number games, such as playing store, playing fireman, and such standard scoring games as bean-bag.

Another type of mathematical experience of the elementary grades, which does not run throughout the school year but is provided by activities of a temporary character that arise in the life of the school or of a grade, is illustrated by the following examples:

Every year each grade provides clothing and supplies for a Thanksgiving dinner to a number of poor families of the city. Some

mathematical work is done by the children in this connection. For example, one year the third grade undertook to supply five families with clothing and Thanksgiving dinners. Lists of the members of the families were given to the children. These lists were written upon the blackboard, so that the children could see the size of each family. From these lists the children made tentative food lists of what they thought was needed for each family. A price list was then secured and the children made the food bills for the families.

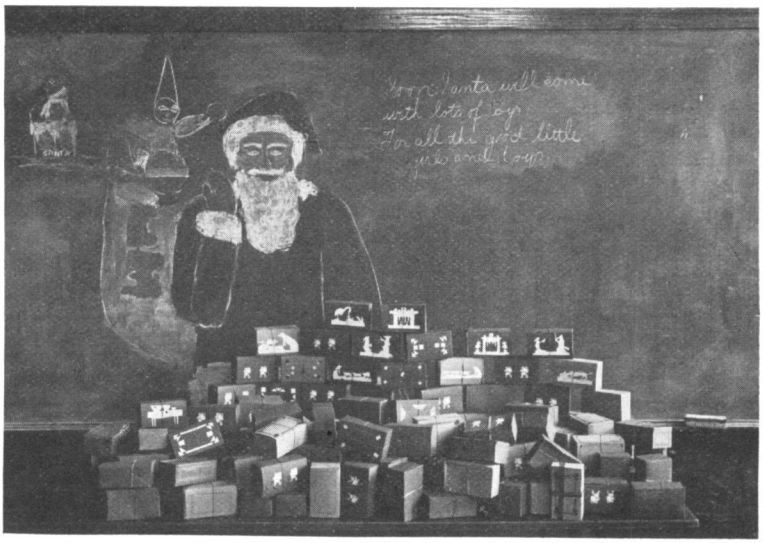
BILL FOR FIRST FAMILY		BILL FOR SECOND FAMILY	
2 chickens	$1.36	1 chicken	$0.68
1 bu. potatoes	.96	½ bu. potatoes	.48
2 cans corn	.18	2 cans corn	.18
1 can tomatoes	.06	1 can tomatoes	.06
1 lb. coffee	.25	1 lb. coffee	.25
1 lb. rice	.08	1 lb. rice	.08
½ lb. tea	.23	½ lb. tea	.23
5 lbs. sugar	.25	5 lbs. sugar	.25
5 lbs. flour	.18	5 lbs. flour	.18
Nuts	.18	Nuts	.18
Fruit	.55	Fruit	.40
Total	$4.28	Total	$2.97

The total cost of the food of the five families was then found. The grade contributed $18.00, and finally from this amount the price of the food was subtracted. The food bills were then taken to the office, where the children actually paid for the food which they sent out to the families at Thanksgiving.

Every year the school sends out with its toys and other packages to poor children at Christmas a large amount of home-made candy, made by the children of the school. Each child to whom the candy is sent is allowed one-half pound. The mathematical work connected with this project is performed for the school by the children of the third grade. The first problem given to the grade is to devise some way in which this candy may be sent out in a clean, attractive, and sanitary way. The following is an account of the work done by the grade one year:

The children of the grade planned and made enough candy boxes to supply all of the children to whom the candy was to be sent. First there was a period of experimentation to determine the size and kind of boxes to make. The children made different kinds of boxes which they thought would solve the problem. These were made with sepa-

rate covers. Since 150 boxes were needed, this scheme really meant the making of 150 boxes and as many covers, really 300 boxes. The children saw the impracticability of such a scheme, and went back to their experiment with new vigor. Sample boxes of many sizes and shapes were brought to school, the children finally accepting one in which the cover was a part of the box itself.



CHRISTMAS CANDY BOXES

With the pattern decided upon, the problem of size next arose. With inch cubes, a block the size of a half-pound box was built up on the table. Much drill in square measure was afforded by this. For example, how many square inches on the ends of a box, on the bottom, on the top, etc. Next came the construction of a working pattern from these cubes. As the children gave the dimensions of base, sides, ends, top, the pattern was drawn the exact size on the board. The bottom, sides, ends, and top were drawn.

Experiment showed that there must be something more to the box if it were to hold together properly. Consequently, paste-flaps were added. A flap that would fit into the box when closed was added to the top. With this pattern before them, the children were asked to determine the smallest square from which the box could be cut, and found it to be an eleven-inch square. The cardboard to be used was bought in sheets, which were 22½ inches by 26 inches. After measur-

ing, the children found that four boxes could be made from one sheet of cardboard, with some waste. All this work again afforded excellent drill in addition, subtraction, and square measure. Next came the estimating of the number of sheets of cardboard required to make 150 boxes.

Before the children were allowed to work with the red and green cardboard, each child had to demonstrate that he was capable of making a perfect box. These trial boxes were made of brown wrapping-paper. When the children had thus proved their ability, work was begun with the red and green cardboard.

After the boxes were planned and cut out, and before they were folded and pasted, the problem of the decoration of them was taken up. Pieces of cardboard, three inches by five inches (this being the size of the top of the box) were given the children for experimentation. Borders, three-eighths, one-half, and five-eighths of an inch wide, were drawn. As another problem in design, the children were told to mark off on white drawing-paper two one-inch squares. The first square was divided into four one-half inch squares; the second was marked off into one-half inch squares, and, in addition, diagonals were drawn. These four small squares and eight smaller triangles that resulted from the cutting were then arranged in many original designs by the children, examples of which may be seen in the picture.

In addition to the great amount of arithmetic incidental to the planning and construction of the candy boxes, such problems as the following also were given to the grade in connection with the Christmas work:

FAMILIES FOR WHOM CHRISTMAS CANDY IS TO BE MADE BY THE FRANCIS W. PARKER SCHOOL:

FAMILY	NUMBER IN FAMILY
Mrs. Lane	11
Mrs. Ruffin	5
Mrs. Stesmak	5
Mrs. Kotells	5
Mrs. Baylie	8
Mrs. Spurling	5
Mrs. Langlus	4
Mrs. Smith	4
Mrs. Morse	10
Mrs. Mascarello	7
Mrs. Ferguson	9
Mrs. Warnick	9

(List of families, continued.)

Mrs. Lucas	5
Mrs. Minkond	9
Mrs. McMahon	9
Mrs. Franklin	4
Mrs. Freundt	4
Mrs. Cutrara	8
Mrs. Calucci	4
Mrs. Thorson	4
Mrs. Delver	4

How many in all are to be provided candy?

Allowing one-half pound of candy for each, how many pounds must we make?

To the Third Grade:

Some of the children who are to make candy for Santa Claus will make it at home and bring it to school. The rest of the candy will be made at school. You found that the whole amount to be made was seventy-one pounds. The children who will make candy at home have agreed to make the following amounts: 3 lbs., 4 lbs., 3 lbs., 4 lbs., 2 lbs., 5 lbs., 2 lbs., 3 lbs., 4 lbs., 4 lbs. and 4 lbs. We want to know how many pounds the other children must make at school.

How many pounds will the children make at home?

Then how many pounds must the other children make at school?

(Signed) .....,
Chairman Candy Committee.

In addition to such problems as those given above, other kinds of problems arise in connection with the Christmas candy-making from year to year. Each year the second-grade children weigh out the sugar for the school to use in making the candy.